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V. Hlasny

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THE POLITICAL ECONOMY OF DEREGULATION IN THE U.S. GAS DISTRIBUTION MARKET

Vladimir Hlasny*

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Causes and consequences of deregulation and restructuring in utility markets in US states continue to draw heated debate. It is unclear why different utilities choose retail restructuring, price caps or sliding-scale plans. Various economic and political reasons lend themselves to explaining regulatory decisions. This study uses a stylized capture model to formulate predictions about regulators' net benefits from a particular form of deregulation. Empirical hazard model evaluates the revealed choice at each regulator-utility pair. Among state-level political factors, frequency and timing of commissioner re-elections, system of selection of commissioners, and party composition of the commissions and state legislatures are significant in explaining the pattern of deregulation. Utilities' prices, capacity and scope of operations help explain the timing of deregulation. Market concentration contributes. A negative significant association between the prevalence of restructuring (and sliding-scale plans), and of price caps across utility industries is identified.

Keywords: gas, deregulation, restructuring, commissioner elections, hazard model

JEL Classification: L51, L95

* Assistant Professor, Department of Economics, Ewha Womans University; and Fellow, International Centre for Economic Research. 401 Posco Building, 11-1 Daehyun-dong, Seodaemun-gu, Seoul, Korea 120-750, E-mail: vhlasny@ewha.ac.kr, Telephone: +82.2.3277.4565.

Since the late 1800s, regulation of public utilities in the United States has undergone many changes in structure and conceptual approach. The most recent upheaval took place in the early 1990s, when many state public service commissions abandoned traditional cost-plus ratemaking regime for performance-based regulation. Some states fixed prices that utilities could charge, some introduced financial incentives for utilities to exceed certain performance standards, and others allowed utilities to compete among themselves for customers. Utilities went along with, if not welcomed, the changes. The first large incentive programs in the gas distribution industry were introduced fifteen years ago, and many states have adopted them since then. As of 2007, half of U.S. states and two thirds of utilities still operated under rate-of-return regulation. To this day, motives behind regulatory reform across individual states remain unclear. Understanding them can help us determine the relative importance of legitimate economic factors, and of political capture motives, in bringing about policy reform. This understanding can also help us predict future patterns of deregulation.

This paper extends empirical evidence on factors behind regulatory reform in utility industries, using panel data on all natural-gas utilities in the continental United States. Among state-level political factors, frequency and timing of commissioner re-elections, system of selection of commissioners, and party composition of the commissions and state legislatures are significant in explaining the pattern of deregulation. Demonstration effects from regulatory regimes in surrounding states and particularly from other utility industries in a state appear to play a role. A negative significant association between the prevalence of restructuring, and of price cap deregulation across states is identified. This may result from the adoption of price cap regulation to block restructuring. It may also result from the preference for price cap regulation in less competitive regions, and restructuring in regions with a sufficient potential for competition. Finally, utilities' prices and capacity, and market concentration, are shown to help explain the outcome and timing of regulatory reform.

1. Background of regulation

Prior to the 1860s, federal government oversaw utility industries from wellheads to city gates. Individual municipalities oversaw distribution companies. Because of simple structure and balkanization of utility industries, there appeared little need for state-level regulation. Between the 1860s and 1920s, utility industries became more integrated, as companies increased scope of their services and regional reach, and their operations spanned out across multiple commodities. Trusts and monopolies arose in railroad and other public utility industries. State commissions emerged, as a Populist (1880s) and Progressive (1890-1910s) response to these trusts. In fact, most state commissions called themselves railroad commissions for many decades even though their function included telecommunications, energy, gas, water and other utilities. The primary objective of the commissions was initially to protect core (i.e., residential and small commercial) customers from being abused to the benefit of larger consumers or utilities themselves (Stigler & Friedland, 1962; Priest, 1993). Over time, state commissions took on more responsibilities, with regard to infrastructure provision and enforcement of efficiency at companies. Today they are the most influential body responsible for supervision of transportation and distribution companies in utility industries.

State commissions have adopted different regulatory approaches across different utility industries, depending on the complexity of service to consumers, ownership and cost of key assets, and prospect of technological innovation. Gas distribution market was traditionally kept under rate-of-return regulation, because of its status as classical natural monopoly. State commissions used tight regulation in order to hold utilities' returns and consumer prices within narrow ranges. In the 1960s, rate-of-return regulation regime came under attack for giving utilities insufficient incentives to manage costs and revenues, and encouraging them to strategically overcapitalize and pass up risky long-term cost-reducing investments (Averch & Johnson, 1962). In protecting core customers' bottom line, regulators had discouraged utilities from marketing to off-grid industrial consumers and procuring gas in innovative ways.

In 1978, the National Energy Act unified the intrastate and interstate transmission markets, and Orders 380 and 436 gave gas providers open access to transmission companies' pipelines. Through the 1978 Natural Gas Policy Act and the 1989 Wellhead Decontrol Act, wellhead prices became competitive. Utilities' options for using their resources and procuring commodity widened. As the national gas market became more integrated, state officials, consumer advocates and utilities themselves started calling for lighter-handed, more flexible and more efficient regulatory regimes. The 1992 FERC Order 636 facilitated regulatory reform by extending utilities' access to transmission, and simplifying price structure in transmission.

Price cap regulation became debated as the means of promoting efficiency. Price caps gave utilities the full reward for efficiency in capital investment and in risk-taking in gas procurement and infrastructure management. The difference between price caps and rate-of-return regulation was, in reality, dampened by regulatory imperfections and constraints. Regulatory lags, rate case moratoria and prudence reviews reduced the efficiency disadvantages of rate-of-return regulation. Accounting for *Z* factors in the calculation of rates, and possibility of ex post renegotiation of allowed rates reduced the utilities' incentives under price caps. Even though price cap regulation required less regulatory oversight than rate-of-return regulation, it did not represent true regime change because – theoretically and empirically – it did not depart sufficiently from the rate-of-return regulation paradigm. Companies' costs and their allowed rates remained tied, and companies' sunk investments remained protected by a safety net. Price-cap regulation also required regulators to correctly predict future costs and technology improvements, else utilities could earn excessive returns or default on their responsibilities. Perhaps because of these reservations, price cap regulation was adopted in a "gradual and sometimes haphazard manner" in the United States (Crew & Kleindorfer, 1996, p. 212).

In the mid-1990s, several state commissions started advancing incentive or performance-based regulation to give utilities incentives in particular areas of operation. Rewards for outstanding performance were reflected in their allowed consumer rates. The first stab at such deregulation, named capacity-release and off-system sale plans, allowed utilities to share benefits from exceptional performance in utilization of marginal resources. The first was adopted in North Carolina in 1993. Some states, starting with Mississippi in 1994, introduced monetary rewards for superb customer service. When these programs were deemed successful, more aggressive incentive programs were authorized to give utilities a wider space for decision-making, such as attracting off-system industrial customers (earnings sharing mechanisms), and purchasing the commodity from various sources (gas cost incentive mechanisms). Utilities were allowed to influence their rate of return on capital by retaining a portion of the difference between actual and benchmark costs or revenues (Comnes *et al.*, 1995).

Sliding-scale programs currently used by US state commissions have several major variations. Margin-sharing plans promote efficient management and divestiture of resources on the margin: Off-system sales and pipeline capacity release plans reward utilities for using excess gas or capacity in their pipelines. Gas-cost incentive mechanisms offer utilities an incentive for efficient gas procurement, in commodities, futures and derivatives markets. Earnings-sharing mechanisms encourage negotiation of special contracts with new industrial customers to make gas competitive with other fuels. Once again, adoption of sliding-scale programs did not represent a true regulatory reform, merely partial, controlled deregulation. Similarly to price-cap regulation, sliding-scale plans retained much of the link between companies' costs and prices, and continued to restrict companies' returns to be within certain ranges.

In 2000, state commissions started departing from the regulatory paradigm based on viewing utilities as natural monopolies. They restructured the gas distribution market by unbundling gas distribution service into several service areas, and approving several utilities and independent marketers to compete in individual segments. Refer to Table 1. Introduction of consumer-choice programs arguably represented true regulatory reform, as it brought about a new view and treatment of individual utilities, industry-wide structural changes, and changes in state commission' role. Moreover, entry of unregulated interstate marketers gave states access to new sources of gas, undercut existing vertical regional supply chains, and helped to further unify the gas market.

	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Sliding scale plans (Utilities)[a]	28	39	48	56	60	63	70	70	71
Price caps (Utilities)	13	15	16	18	19	20	21	21	21
Consumer choice (States)	0	1	8	14	19	19	20	20	20

[a] This count does not include Wyoming utilities (44), who all receive 10% of gas cost savings under state legislation.

Table 1. Cumulative Number of Policies in the Dataset, by Year

2. Regulatory literature

Most research on public utilities has focused on the electric and telecommunications industries, and has evaluated performance of regulatory regimes, rather than reasons for their adoption. Hlasny (2006, 2008a, 2008b) reviews these studies. Economic studies of the causes of regulatory reform have identified various political factors behind deregulation in utility industries (Bailey & Pack, 1995): presence of infrastructure necessary for restructuring (Comnes *et al.*, 1995); political party in power and composition of public service commissions; commissioner re-elections (Dalbo, 2006; Hagerman & Ratchford, 1978); pressure from various interest groups

(Hilton, 1972; Stigler, 1971; Posner, 1974; Peltzman, 1976; Becker, 1983); and satisfaction with restructuring in surrounding states or industries (Flippen & Mitchell, 2003). Other economic factors include monopolistic behavior and high prices of incumbent firms (McCraw, 1975; Ando & Palmer, 1998; Hlasny, 2010); recouping of stranded costs of utilities' long-term investments (Flood, 1992; Gilbert & Newbery, 1994; Salant, 1995; White *et al.*, 1996); and other economic trends (Joskow *et al.*, 1989; Dalbo & Ditella, 2003).

Empirical evidence on the causes of deregulation has been mixed. In the electricity industry, the process of regulator-selection has had little impact on the stringency of regulation in terms of the consumer prices (Costello, 1984; Primeaux *et al.*, 1984; Primeaux & Mann, 1986; Boyes & McDowell, 1989; Campbell, 1996; Kwoka, 2002; Besley & Coate, 2003) and the allowed rates of return (Joskow, 1972; Hagerman & Ratchford, 1978; Harris & Navarro, 1983), but some impact on the length of regulatory lag (Atkinson & Nowell, 1994). The process of creation of consumer advocate groups affected the stringency of the regulator's price setting and cost review (Holburn & Spiller, 2002; Holburn & Vandenbergh, 2006). The expected gains to consumers from lowering incumbent utilities' prices resulted in restructuring in the energy industry (White *et al.*, 1996). The level and variance of prices in a state and prices in neighboring states have influenced the likelihood to restructure the energy industry in a state through opportunities for the use of utilities' reserve margins (Ando & Palmer, 1998). In telecommunications, the effect of the regulator-setting process (Smart, 1994) and of campaign contributions (Edwards & Waverman, 2004; DeFigueiredo & Edwards, 2005) on pricing has been noted.

3. Estimable model of regulatory choice

The empirical analysis herein is loosely based on a theoretical model of rational regulatory choice, following Peltzman's (1976) capture model. At the center of the regulatory process is a regulator who chooses among regulatory regimes P_{ij} with the objective to maximize a measure of his political returns $W_i(P_{ij})$. The regulator's return may be in the statewide consumer or producer surplus, state revenue, chances of re-election, financial contributions, popularity, prestige, sense of righteousness, or a combination of these. The regulator selects the regime that yields the greatest returns.

$$W_i\left(P_{ij}\right)=\sum_{g=1}^{G}\left[n_g \cdot f_g\left(P_{ij}\right)\right] \qquad [1]$$

In this expression, subscript i is for the regulator, and j is for the utility under consideration. P_{ij} is a categorical policy variable whose Π possible realizations include the decision to retain the status quo regime. Regulator i's political returns are a sum of the returns obtained from G groups of stakeholders. G includes non-overlapping groups such as other governmental bodies, taxpayers, voters, different classes of consumers, shareholders, utility workers, other utilities and others. The returns from each group g depend on the size of the group, n_g, and the measure of support from a typical member of g for the policy reform in question, $f_g(P_{ij})$. The form of $f_g(\cdot)$ depends on the marginal support that a typical member of g tenders for P_{ij} when the present value of his wealth increases by one dollar as a result of introduction of P_{ij}. $f_g(\cdot)$ may thus depend on an individual's existing wealth, time preference and risk aversion.

f_g can be a probability that an individual grant his support for P_{ij}, or the money or utility transfer to the regulator, conditional on P_{ij}, or a vector of variables of interest. $f_g(\cdot)$ may be increasing and weakly concave, because of positive non-increasing marginal contribution of individuals' net benefits of regulation to their support for P_{ij}. Different groups may have different functional forms of f_g. Without information on the exact variable whose value state commission strives to maximize, no other restriction should be placed on f_g. Specifically, $f_g(P_{ij})$ may depend on the present value of direct benefits from particular policy reform, costs to implement and enforce the new regime, and mitigate or appease opposition, and costs of organizing within the group g.

Direct benefits from policy reform may depend on the change in individuals' earnings (e.g., from off-system sales) or savings (from lower prices) anticipated if new regime is adopted, including direct costs of adoption. Costs to enforce a policy may depend on the necessary spending (e.g., information gathering, and dissemination or concealment) and transfers to other groups to ensure adoption of a policy. Costs of organizing a group may depend on the difficulty of tallying individual members' valuation and organizing them (overcoming free riding and mobilizing members), and may therefore be a function of the size of a group. Direct benefits from policy reform, T_g, may be positive or negative. We may have $\sum_{g=1}^{G}\left(T_g\right)\neq 0$ for a particular P_{ij}, or $\sum_{P_{ij}=1}^{\Pi}\left(T_g\right)\neq 0$ for a particular g. Costs to enforce a policy, K_g, may be $K_g(P_{ij})<0$ if g receives a transfer from another group h ($h\in G$, $h\neq g$) to enforce a policy (particularly if groups differed in their voting rights or weights in the regulator's objective). Both $T_g(\cdot)$ and $K_g(\cdot)$ may depend on the sizes of other interest groups n_h.

In reality, regulatory decisions are not made by the state commission alone. Various stakeholders, including the utility in question, have input in the process. Back and forth negotiation weakens the power that the regulator or utility may exercise in implementing policy reform (Mathios & Rogers, 1989; Greenstein *et al.*, 1995). Equation 1 allows for these considerations. The regulator faces a tradeoff in the support he receives from different interest groups, and selects policy reform P_{ij}^* that maximizes their sum. Knowledge of the individual parts of Equation 1 would shed light on why particular regulatory regime is adopted at a utility-regulator pair at a particular point in time, and which forms of regulation are likely to be used in the future.

For simplicity of presentation, Equation 1 omits time subscripts. The regulator's problem is of course dynamic. The size of individual interest groups, the net benefits expected by them and the rules of admissibility of their support change over time. Flows of net benefits, costs of lobbying and of organizing groups occur at different points in time, with different certainty. Furthermore, the regulator's identity and the form of his political returns may change over time.

3.1 Empirical approach

Decisions about alternative policies should be studied jointly, since the regulator has a number of deregulatory options from which to choose, and the decision to adopt a particular policy depends on the set of available policy options. The probability and timing of implementation of a particular mechanism are thought to depend on expectations of all stakeholders regarding the net benefits from a particular form of deregulation, as compared to other policy alternatives.

One can study the revealed choice at each regulator-utility pair to identify factors affecting the decisions as well as the individual parts of $W_i(P_{ij})$. Ideally, one would infer the support function $f_g(\cdot)$ of a typical stakeholder in each interest group g for each considered deregulatory regime P_{ij}. Unfortunately, information on utility functions of individual public service commissions and all stakeholders is missing. The exact functional form and arguments of $f_g(\cdot)$ are unknown, and are difficult to estimate for policy regimes that have not been enacted. The identity and size of all interest groups is also unknown. Most data are available only at the state or utility level. As a result, the following empirical model studies factors behind deregulation at the levels of the public commission and the utility.

Given the available data, several conjectures suggested by previous literature can be tested. One conjecture related to the capture theory is that the process of selecting public service commissioners may influence the form of deregulation. Whether the selection is through appointment by state legislature or through public election; number of (re)appointments in the current year; and the length of election cycles may matter. Unfortunately, the direction of these effects is a priori unclear, as it depends on commissioners' campaign programs and voters' sentiments, unobservable in this analysis.

Another conjecture testable using the available data is that previous experience with similar forms of deregulation in other industries in the state, or in the gas market in surrounding states, yields demonstration effects that impact the expected benefits of deregulation. Provided that the previous experience is positive, one could expect positive demonstration effects.

Among economic factors, one conjecture is that higher consumer prices at a utility encourage deregulation. They may increase the expected price reductions under deregulation relative to the status quo. A benevolent regulator may be sympathetic to the consumers' cause particularly at high prices.[1]

Another interesting economic conjecture is that the measure of effective industry concentration encourages the adoption of price caps. Even though most utilities are monopolies in their local markets, they compete to attract off-grid customers and to win regulator's support in cost review cases and performance evaluations (e.g., service quality awards). For these reasons utilities strive to compare favorably to other utilities in the state. The higher the concentration of utilities, the less effective competition of this sort may exist, and the more of monopolistic and exploitative behavior one may observe. The regulator may then prefer price caps to rate-of-return regulation. Price caps treat a utility in isolation, fixing the service quality and other operating standards, and inducing the utility to increase its efficiency, regardless how low competitive pressures from outside are. Sliding-scale and consumer-choice programs, on the other hand, may be expected to operate best in industries with lower concentration. Sliding-scale

[1] High prices may signify improprieties by the utility. Also, while utilities may be thought to have constant marginal utility of money, consumers' marginal utility increases with prices. Regulator may be particularly sympathetic to residential consumers, who face diminishing marginal utility of money; for whom utility bills represent a large portion of incomes; and whose support in $W_i(P_{ij})$ can be substantial.

plans are based on a comparison of a utility's performance against the performance of other utilities. Among sliding scale plans, earnings-sharing plans reward utilities explicitly for acquiring new customers, and margin-sharing plans reward a utility for sharing its resources with other utilities profitably. Consumer choice programs require the presence or the potential for entry of competing providers of unbundled services.

A related conjecture is that utility size affects the expected benefits from deregulation. Larger utilities have larger interest groups (n_g) that may be better organized; have generally been in existence longer and may have earned more trust from the regulator; and may be perceived as less competitive by general public (because of their sheer size). For these reasons, utility size may affect the benefits from deregulation expected by the utility and consumers. A priori, it is unclear whether utilities' size should be related positively or negatively to the hazard of deregulation relative to the status quo. Among the possible forms of deregulation, we may believe that larger utility size is conducive of utility-level incentive programs. Utility size is unimportant or may be harmful when regulatory reform relies on effective competition among utilities.

One may formulate other hypotheses of interest beside those above. Unfortunately, many hypotheses cannot be tested using currently available data. In particular, direct pressure by various interest groups, or utilities' rates of return, stranded costs and reserve margins are missing. Some conjectures are difficult to test because of interplay of competing effects in the real world. For example, incomes affect consumers' marginal utility of money, but also voting behavior, preferences and attitude toward risk; prices of alternative fuels affect each stakeholder differently, and may be correlated with unobserved features of statewide gas industry.

3.2 Cox model of time to deregulation

The Cox proportional-hazard model is estimated to predict the time to deregulation of utilities that have not deregulated yet, using information on the timing of deregulation at presently deregulated utilities. The standard model is advanced to allow for competing risks of adoption of one or more of the alternative deregulatory plans. In a discrete-time model, the hazard of an event is the probability that the event occurs in a time period, conditional on the fact that it has not occurred until then. The hazard rate of adoption of a program π at each regulator-utility pair

ij in year t, $\lambda_{ij\pi t}$, is frequently modeled as an exponential function of determining factors, multiplied by an estimated baseline hazard rate of adoption: $\lambda_{ij\pi t} = \exp(\gamma_\pi \cdot Y_{ijt}) \cdot \lambda_{00\pi t}$. In this expression, Y_{ijt} is a vector of time-varying explanatory variables specific to each regulator-utility pair ij, γ_π is the associated vector of coefficients specific to policy π, and $\lambda_{00\pi t}$ is a duration-dependence baseline hazard rate of policy π as of time t.

Y_{ijt} includes time-varying factors at the levels of utility, state regulator, and nation-wide gas market. To the extent that each regulator-utility pair has a particular expectation of conditions resulting under each policy alternative, the model should include policy-specific controls. However, such expectations could differ between the regulator and the utility, and information on such expectations is missing. Detailed provisions of each utility-specific mechanism are also unknown.

$\lambda_{00\pi t}$ is the hazard rate of adopting π conditional on all control variables being set to zero, and therefore does not depend on the regulator's or the utility's characteristics. Typically, one needs to estimate $\lambda_{00\pi t}$ along with all model coefficients. This need can be eliminated using a partial-likelihood maximization method, by focusing only on the contribution of ij's time to deregulation to the ordering of times across all regulator-utility pairs, conditional on the set of regulator-utility pairs that have not deregulated as of t.

To allow for competing risks in the above Cox model, the hazard of adoption of a policy must be independent of the choice set of available deregulatory programs.[2] Empirically, only some combinations of policies or progressions between policies are feasible. However, modeling of the allowed relationships among available policies would be difficult. It is implicitly assumed that any policy can be implemented alongside any other policy, and arbitrary progression between any two policies over time is allowed.

[2] To evaluate reasonableness of this assumption, the results of a joint competing-risks model are compared against a model stratified by policy alternatives or by distinct time periods (Harrell and Lee 1986). The results are available on request. Since restructuring became a viable policy option only in year 1999 (after the initial pilot programs proved feasible, and upon support from federal legislation), periods 1996-1998 and 1999-2004 are distinct in the effective menu of available policies, and can be used for stratification. (The experience with restructuring in California and Georgia became known only in the second time period. Delaware and Wisconsin also discontinued their pilot programs in the second time period.)

3.3 Data

Data for this analysis come from several public sources, most importantly the Department of Energy, National Association of Regulatory Utility Commissioners, and webpages of state public service commissions. The data covers all large-capacity utilities in the continental US reporting on the Department of Energy's EIA-176 form during 1996-2004. To limit the heterogeneity of utilities in the sample, three-quarters of utilities with the smallest capacity are dropped, reducing the sample size from 2,222 utilities (12,941 observations) to 659 utilities (3,646 observations). Small utilities appear to be regulated differently than medium-size and large utilities, and have other systematic differences. Information on why each of these utilities is different is missing, and dropping them appears to be the best option. The analysis was repeated using all utilities, and all qualitative results remain valid.

Hawaii and Alaska are outliers in the dataset, both conceptually and empirically, and suffer from missing data. These states are excluded. Californian utility industries have undergone extensive structural and political changes in recent years. During the period under analysis, the state experienced energy industry price-fixing scandals, financial crises, and the resulting policy changes. After evaluating the effects of the uncompetitive activities on regulation in the region, California was not dropped from the analysis, because its presence does not alter the results greatly.

Information on the form of regulation comes from a custom survey of state public service commissions, conducted for accuracy three times between 2001 and 2007 (Hlasny, 2006, 2008a). Table 2 describes the presence of deregulatory programs in the sample, including their joint distribution. Information on the composition of state public service commissions, system of selection of commissioners, and times of (re)appointments comes from NARUC (2010), Beecher (2007, 2010), and commissions' websites. Other data on state and national elections are taken from the US Census. Hlasny (2010) reports the source and description of economic control variables.

Program	States	Utilities	Observations
Consumer choice–pilot or implemented[a]	22	216	721
Price cap[b]	4	7	20
Sliding scale plan[ab]	21	37	134
Sample size	47	659	3,646

The reported number of states, utilities and observations have information on years prior to deregulation, needed for the analysis. Programs implemented before 1996 are dropped.
[a] Of these numbers, 10 states, 16 utilities and 29 observations have both consumer choice programs and sliding scale plans.
[b] Of these numbers, 2 states, 4 utilities and 8 observations have both price caps and sliding scale plans.

Table 2. Inventory of Policies in the Sample

Number of commissioner positions open for (re)appointment, process of selecting new commissioners, and length of election cycles control for time-variation in regulatory motives at the state level. Size and composition of the commission, and political party prevalent in the state legislature control for party objectives. Controlling for the state commissions' experience with deregulation is the number of deregulatory programs in the gas market in surrounding states, and the number of deregulatory programs in other utility industries within the state, as of year *t-1*.

Herfindahl-Hirschman Index (HHI) for the concentration of utilities in the state gas distribution market measures inversely the amount of interaction among utilities and strength of competitive forces in the industry. State is chosen as the definition of utilities' market out of conviction that this measure of market concentration is closely related to the effective amount of competition that a utility faces, and for a lack of better information. State boundaries provide some effective restrictions on utilities' operations (e.g., requirements to be licensed in a state to compete there, and to deal with transmission companies in a state), and so the HHI in the state market is expected to be a better measure of the effective interaction among utilities regardless of state size than, say, a uniform-size market definition.

State per capita incomes, unemployment rates, bankruptcy rates, personal and business income tax rates proxy for the fiscal environment in the state, including consumers' ability to pay. Residential prices, capacity, operation type and ownership are used to control for utilities' observable and unobservable time-varying characteristics and performance.

With the exception of categorical variables and the HHI, all variables are normalized by the nationwide average of the variables for a year. This normalization picks up relative differences across utilities (or states) rather than variation over time, and is insensitive to nationwide year-specific shocks. Units of the normalized variables are the percentage deviations from the national mean. Another set of controls is obtained by normalizing variables by their average for the utility (or state) in all prior years. This normalization picks up year-to-year shocks rather than differences across utilities, thus measuring time-varying factors at a utility. Both sets of variables – those normalized by a nationwide average, and those normalized by a utility's prior average – were evaluated simultaneously. This allowed the model to distinguish variation in a regressor across utilities, and over time, as distinct factors affecting the time to deregulation. Furthermore, the mean of these normalized variables is zero. This implies that the computed baseline hazards can be interpreted as the hazards of adoption of a policy by a typical utility in a typical state.

Some of the needed variables are unobservable or measured imprecisely in the data. Policies are measured by binary indicators for the adoption of the policies at a utility, regardless of the detailed provisions of the policies. This is a limitation to the extent that the same policies may vary across utilities by their incentive power, number of affected customer classes, number of customers, agreed upon time span and other factors. Utilities with the same policy are thus implicitly assumed to be regulated subject to similar gas procurement, pricing, cost recovery and rate-of-return rules. In reality, policy with a greater incentive power, extent and time span may be more difficult to implement. Inclusion of these factors would render the above model difficult to solve. The degrees of freedom would also fall with the number of categories of regulatory outcomes. Finally, information on the detailed provisions is often missing or unclear.

Earnings-sharing, margin-sharing and gas-cost incentive plans are studied jointly as sliding-scale programs. Some of these programs are adopted very rarely. In the analysis, even fewer occurrences may appear if some of the independent variables are missing for a utility with the program. With a small portion of the sample under policy treatment, the estimated coefficients would be imprecise. The second reason is that the degrees of freedom in the analysis falls with the number of competing policies, because each policy requires estimation of another set of coefficients and another baseline hazard. Making different sliding-scale plans interchangeable with each other is acceptable, provided they are similar in their adoption processes.

4. Results

This section reports the results of Cox regressions, estimating the time-dependent hazard of adoption of each policy. Table 3 reports on the Cox hazard models where all deregulatory programs are evaluated jointly, thus controlling for the risk of adoption of other programs at the utility. Hazards presented in Table 3 account for the fact that several alternative policies compete for adoption simultaneously.[3] Baseline hazard in this model is assumed the same across the three policies, but most regressors are allowed to contribute differentially to the respective hazards. Each policy thus has a different hazard of adoption.

[3] First, competing deregulatory programs were evaluated individually. In the study of implementation of policy *A*, utilities adopting policy *B* were treated as non-deregulated, and their observations as right-censored. Because competing policies were treated as equivalent to the benchmark rate-of-return regulation, coefficients in this model are interpreted as contributions of a variable to the hazard of adoption of a given policy, against the hazard of adopting another policy (including retention of the benchmark policy). An important limitation of the policy-specific model is that it evaluates the hazard of adoption of only one policy at a time, treating all other alternatives as equivalent to the benchmark. It is likely that the decision between rate-of-return regulation and restructuring, for example, depends on whether the utility currently operates under rate-of-return, price-cap or sliding-scale regulation. In addition, one of several types of deregulation can result, and a low estimated hazard of restructuring should not necessarily be interpreted as a high hazard of retention of rate-of-return regulation. One must remember what policy outcomes are contained and most prevalent in the benchmark when interpreting the coefficients. For these reasons, policy-specific analysis does not appear justified, and joint estimation is more appropriate.

	Sliding scale	Price cap	Choice	Sliding scale	Price cap	Choice
Commissioners	0.005	1.111	-0.711***	-1.781*	1.562	-1.110***
chosen in *t*	(0.715)	(0.873)	(0.168)	(1.052)	(1.105)	(0.214)
Appointed	0.799	0.27	1.154***	0.022	-3.048**	0.455*
v. elected	(0.550)	(0.618)	(0.268)	(1.047)	(1.441)	(0.244)
Election cycle	0.042	-0.308	-0.201***	0.1	-1.234***	-0.197**
length	(0.215)	(0.298)	(0.068)	(0.480)	(0.269)	(0.084)
Democrats	0.207**	0.184	-0.102***	0.154	0.889**	-0.158***
on commission	(0.085)	(0.157)	(0.033)	(0.174)	(0.362)	(0.049)
Democrats	-1.668	-0.164	-0.547	0.328	6.410*	-2.183***
in Upper House	(1.051)	(1.613)	(0.672)	(1.679)	(3.888)	(0.717)
Commission	-0.497**	-0.788	0.323***	-0.888*	-2.616***	0.388***
members	(0.251)	(0.507)	(0.065)	(0.517)	(0.769)	(0.105)
Sliding scale plans				-1.037		1.084***
in electr. industry				(0.699)		(0.264)
Price caps					6.134***	-1.498***
in telecom industry					(1.960)	(0.297)
Price caps					0.236	-0.443*
in electr. industry					(1.163)	(0.227)
Sliding scale plans in				-0.138		0.590***
gas industr. in region				(0.314)		(0.081)
Price caps in					-0.194	-0.430***
gas industr. in region					(0.575)	(0.145)
Choice programs in						-1.658***
gas industr. in region						(0.360)
Price of gas				0.290***	0.077***	-0.117***
v. other utilities				(0.063)	(0.020)	(0.034)
Price of gas				-0.797***		0.079
v. previous years				(0.198)		(0.051)
Utility volume				0.006***	0.023***	0.001
v. other utilities				(0.002)	(0.005)	(0.001)
Herfindahl				0.224	0.786**	-0.051
-Hirschmann Index				(0.252)	(0.326)	(0.062)
Pers. income				1.234***	1.417**	0.418***
v. other states				(0.335)	(0.608)	(0.102)
Pers. income				-3.652**	-6.629***	-3.566***
v. previous years				(1.619)	(1.711)	(0.361)
Business income tax				0.147**		0.147**
v. other states				(0.061)		(0.061)
Records (Utilities) [States]		10,938 (659) [47]			10,257 (657) [47]	
Log pseudo-likelihood		-2,134.51			-1,635.75	
Chi-square		400.03			1,275.78	

* statistically significant at 10%; ** 5%; *** 1%, two-sided tests.

Baseline hazards are same across policies except for differential contributions of regressors. Standard errors are corrected for heteroskedasticity and autocorrelation at utility. Monetary terms are in 1996$. Price and volume of gas sold are at utility level. Type of operation and ownership of utilities are controlled for. State prices of coal and electricity are controlled for in the economic model. Number of programs in region excludes program at that utility. Commission and legislature data, programs in other industries, fuel prices, income, unemployment, income tax and Herfindahl-Hirschman Index are at state level.

Table 3. Cox Proportional-Hazards Model Results

First three columns in Table 3 make the hazard of deregulation a simple function of political factors at the state level. Selection process of state commissioners, size of the state commission, and political party in power control for the political climate in the commission and in the public sphere. In particular, the number of seats up for reassignment on the state commission, party responsible for the selection, and the composition and tenure of state commission control for commissioners objectives and the climate in which they make decisions. Political leaning in the Upper House of state legislature controls for state-level political climate. The three columns on the right control for regulatory experience from other industries and economic factors, to identify better the partial effects of political factors on regulatory reform. Deregulation status in the telecommunications and the electricity industries in the state, and deregulation status of natural gas utilities in other states in the region control for demonstration effects. Economic control variables at the utility level include residential price of gas, utility's capacity, type and ownership. At the state level, other economic controls include concentration of the gas industry, state per capita income, business income tax rate, and prices of related fuels. They help proxy for fiscal and regulatory climate in the state.

First six rows in Table 3 report on the effects of political factors on the hazard of adoption of the three competing deregulatory regimes. The number of commissioner seats up for election or reelection in a year is positively related to the hazard of deregulation via price caps, and negatively related to the hazard of other forms of deregulation. It appears that deregulation via sliding-scale and consumer choice programs is politically more difficult (statistically significant) than adoption of price caps or retention of status quo in years when many commissioners seek to be appointed. The process of commissioner selection also appears to affect regulatory reform, with appointments by state legislature favoring sliding scale regulation or restructuring, and public elections favoring price caps. Thus, when public sentiment is needed in commissioner appointments, state commissions tend to push through price caps, even against the status quo rate-of-return regulation. They appear to shy away from other forms of deregulation. This is further confirmed in the third row: The more often the commissioner selection is conducted – because of shorter election cycles – the higher the hazard of price caps compared to consumer choice and particularly compared to sliding scale plans. In sum, the extent of commissioner elections in a year, the involvement of general public in them, and frequency of elections, tend to favor price caps, over other possible deregulatory regimes or the status quo.

The fourth and fifth rows report on the effects of political-party composition of state commissions and state legislatures. Democratic leaning of the commission and of state legislature tends to favor deregulation via price caps (weakly even sliding scale plans) against restructuring. This may agree with our beliefs regarding Democratic and Republic legislators' attitudes toward competitive forces in the marketplace and toward economic governance. One interesting finding worth studying further is that commissions that have fewer members tend to favor price cap and sliding-scale deregulation, and avoid restructuring. This may be an artifact of complexity inherent in full-blown restructuring, and of other facets of the decision-making process behind regulatory reform.

The following six rows in Table 3 show that policies adopted in other utility industries in the state, and in the gas industry in other states have a strong effect on the hazard of adoption of the same policy at a gas utility. Prevalence of price caps in the telecommunications and electricity industries in the state affects the hazard of price cap deregulation positively, and that of restructuring negatively. Prevalence of sliding scale plans in the electricity industry in the state surprisingly has a negative effect on the hazard of this form of deregulation in the gas industry (insignificant), and a positive effect on the hazard of restructuring.[4] Deregulation in the gas industry in surrounding states appears to have the unexpected effect on deregulation in a state: experience with restructuring (sliding-scale plans or price caps, respectively) in surrounding states lowers the hazard of restructuring (sliding-scale or price-cap adoption, respectively) in a state. This is significant for the hazard of restructuring. The one expected result is that the prevalence of sliding-scale plans (price caps, respectively) in surrounding states raises (lowers, respectively) the hazard of restructuring in a state. Once again we find a strong negative relationship between the usage of price caps, and of consumer choice programs across utility industries in a state, and across U.S. regions. On the other hand, there appears to be a positive relationship between the adoption of sliding-scale plans and consumer choice programs.

[4] This variable, as well as sliding-scale and consumer-choice regulation used in other states, price of gas compared to previous years, and business income taxes are omitted from the price-cap regression to preserve degrees of freedom. Table 2 has already reported that there are only 7 subjects (20 observations) adopting price caps in our sample. If some explanatory variables are missing for those utilities, we would have even fewer adoptions in the regression. It also turns out that information on utilities' prices is sometimes missing. Business taxes are also less significant and less *a priori* relevant in the model.

The next three rows show coefficients on utility-level economic variables. First, an attempt is made to differentiate the effect of premiums in utilities' residential prices relative to other utilities, and jumps in prices relative to previous years. The first variable is normalized by its mean across all utilities for the year. These coefficients are interpreted as contributions of a percentage premium in the variable, compared to values in other utilities, to the hazard of adoption. The second variable is normalized by its up-to-date mean at the utility level. These coefficients are interpreted as contributions of a percentage change in the variable, compared to its previous levels, to the hazard of adoption. Residential price of gas affects the hazard of sliding scale plans and price caps positively, and consumer choice negatively. Compared to the levels in previous years, higher prices of gas tend to decrease the hazard of sliding scale plans. These price effects may together imply that utilities that are less efficient than their peers – in the sense of charging higher regulated prices – tend to be assigned incentive regulation tailored to the particular utilities: price caps or specific forms of sliding scale plans. Regulators may hope to change utilities' performance under new utility-level payoff regimes. Furthermore, sliding-scale plans may be granted only when the utilities show some improvement in prices over previous years.[5]

Utility's capacity increases the hazard of deregulation via sliding scale plans and price caps, and has no effect on the prospect of restructuring. Although the effect of utility size on deregulation (holding market concentration fixed) is theoretically unclear, the estimated effect is not surprising, implying that the amount of resources and experience – and perhaps even the effective or perceived market power, or ability to lobby regulators, or absolute level of benefits to ratepayers – at the utility can raise the expected success of utility-level deregulation. These same factors are unimportant or counterproductive to facilitating competition under restructuring.

The last four rows show the estimated effects of state-level economic controls, as varying across states or years. HHI for the state gas market has a positive effect on the hazard of sliding scale plans and price caps, and no effect on restructuring. Thus, concentration of utilities in the market has similar influence on deregulatory efforts as utilities' size, a nice expected result.

[5] Another explanation of this system of coefficients is that the two variables – demeaned across all utilities, or normalized by the average for all previous years – are collinear, and their coefficients may be spurious. However, the coefficients are statistically highly significant, and the two variables have low correlation. This indicates that multicollinearity is not a problem here.

The next two rows attempt to differentiate the effect of premiums in income levels compared to other states, and jumps in income levels compared to previous years. Higher per capita incomes (relative to other states) are associated with higher hazard of adoption of each deregulatory program. Jumps in per capita earnings (relative to previous years) are associated with a large fall in the hazard of adoption of all programs. Variation in corporate income tax rates across states is related positively to the hazard of sliding scale plans and consumer choice. (To preserve degrees of freedom, the coefficients were restricted to be identical in the two equations, and the variable was omitted from the price-cap equation.)

There is one potential limitation of the models presented in Table 3 that should be mentioned. The hazard model relied on the assumption of proportional hazards – for any two utilities, the ratio of the estimated hazards should remain constant regardless what other plans are available. Kaplan-Meier observed and predicted survival curves can help evaluate this assumption. Refer to Figure 1. The closer the observed values are to the predicted values, the less likely the proportional hazards assumption has been violated. The predicted curves are very close to the observed values, thus alleviating fears that the important assumption was violated. This is confirmed in Figure 2, showing the Kaplan-Meier log-log survival curves of individual policies against log-time. The proportional-hazards assumption appears to be valid for these survival curves, because the curves are nearly perfectly parallel.

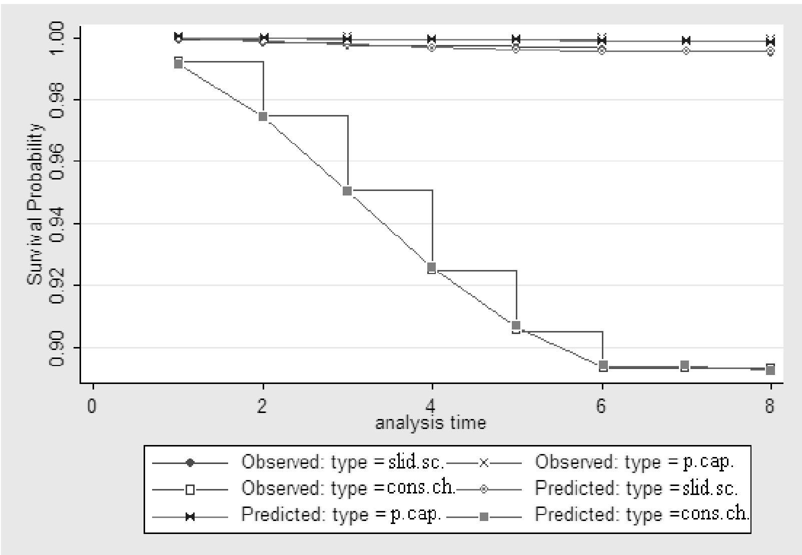


Figure 1. Observed and Predicted Survival Curves for Competing Deregulatory Regimes

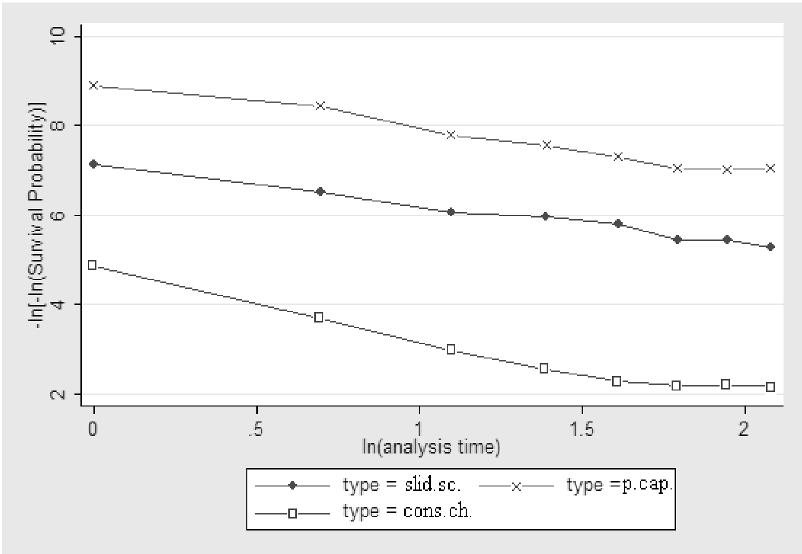
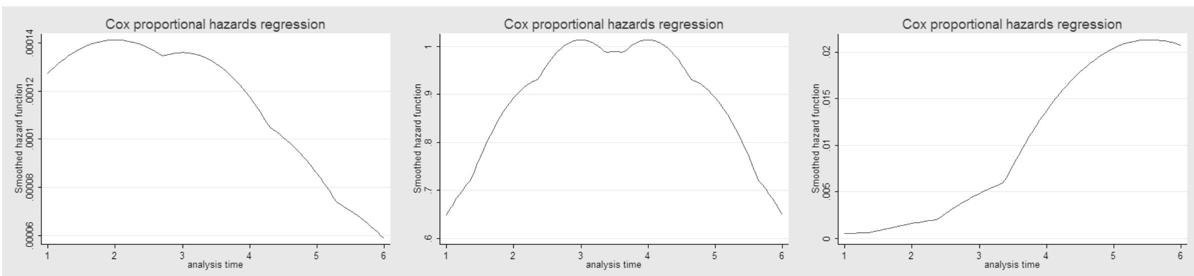


Figure 2. Log-Log Survival Curves for Competing Deregulatory Regimes

Figure 3 shows the baseline hazard estimates (smoothed using kernel density estimation) for each deregulatory regime at the means of all covariates. The hazard of adoption of sliding-scale and price cap forms of regulation falls over time, whereas the hazard of restructuring rises. This corresponds to the fact that the vast bulk of the sliding-scale plans and price caps were adopted in the late 1990s, while consumer choice programs started to spread only after the year 2000. The three graphs indicate that the assumption of equal baseline hazards across policies would not be valid. Clearly, no two policy alternatives can be combined into one, and each policy should be modeled with own baseline hazard.



(a) Sliding scale regulation (b) Price cap regulation (c) Consumer choice regulation

Figure 3. Smoothed Estimates of Baseline Hazards of Competing Deregulatory Regimes

5. Conclusions

This study has evaluated selected political and economic factors affecting the likelihood and timing of regulatory reform in the gas distribution market. Three deregulatory regimes were studied jointly – sliding-scale incentive regulation, price cap regulation, and restructuring with consumer choice. Results indicate that the process of selecting state public service commissioners is an important determinant of regulatory outcomes at utilities. The extent of commissioner elections in a year, the involvement of general public in them, and frequency of elections, tend to favor price caps, over other possible deregulatory regimes or the status quo. Political-party composition of state commissions and state legislatures contributes. Democratic leaning of the commission and of state legislature tends to favor price caps against restructuring.

Adoption of price caps and consumer choice programs in other utility industries in the state has a positive and significant demonstration effect on the adoption of these norms in the gas industry. Demonstration effects from the gas industry in surrounding states are weak and unclear. This may correspond with the fact that policy reforms have not been successful in all states where they were undertaken during 1996-2004. Whether demonstration effects will become clearer and positive in the coming years presumably depends on actual performance of existing programs.

After controlling for a number of political and economic factors, there remains a clear negative association between the prevalence of consumer choice – together with sliding scale – regimes on the one hand, and price cap deregulation on the other hand, across utility industries in a state, and across U.S. regions. The systematic negative association between restructuring and price cap regulation may be caused by the usage of price cap regulation to block restructuring, and the adoption of sliding scale plans as a preparatory step for successful restructuring. This association may also result from the correlatedness of political climates, electoral systems, composition of gas industry, and availability of resources (such as gas wells, underground storages or pipeline capacity) across U.S. states. Sliding-scale regulation appears to have similar criteria for adoption as restructuring, while the criteria for price cap regulation are contrary.

At the utility level, residential prices and utilities' size affect the hazard that the utility will be deregulated, positively for price caps and sliding-scale plans, negatively or insignificantly for consumer choice. The estimated effect of utilities' size may imply that the amount of resources and experience – and perhaps even the effective or perceived market power, or ability to lobby regulators, or absolute level of benefits to ratepayers – at the utility can raise the expected success of utility-level deregulation. These same factors are unimportant or counterproductive to facilitating competition under restructuring. Concentration of utilities in the market has similar influence on deregulatory efforts.

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